Space Weather Technical Forecast

Issued on Sunday, 03 July 2022 at 01:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1/Minor Storms throughout the forecast period.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low through the last 24 hours with no significant flare activity. There are six active regions on the disc, of which two are notable. AR3040 (Cso/Beta) on the southwest limb is mature and fading. AR3046 (Cso/Beta) is developing, with the emergence of a trailer region. This region also produced a B7.3 flare, which may be the sign of further development and activity. The remaining regions are all weak, benign or fading. No Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: The solar wind speed as observed at L1, has followed a declining trend through the last 24 hours from 350km/s to 330km/s. Density has varied erratically, with a peak of 37ppcc at 01/2258UTC followed by a sharp decline and then peak to 19ppcc at 02/0345UTC. After a further decline, the density steadily increased, reaching between 20-25ppcc by the end of the period, potentially indicating a further CME arrival. These observations are indicative of the presence of the magnetic cloud from the CME which arrived late on 01 July. Total magnetic field strength started at moderate levels, around 13nT, due to the CME magnetic cloud, with the strength easing to 4nT by the end of the day. The north-south component, Bz started mainly negative, with a negative peak of -13nT at 02/0403UTC. It has been mainly positive since 01/1056UTC, with a positive peak of 9nT at 01/2119UTC. Phi angle started positive (away from the Sun), but has been negative since around 01/0400UTC. Geomagnetic activity was mainly Active between 02/0000-1200UTC with a G1/Minor Storm interval between 02/0300-0600UTC. Activity has been Quiet since 02/1200UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) as measured by GOES16 remained at background levels throughout the period. The high energy electron flux (greater than 2MeV) has been at mainly background levels through the last 24 hours. Electron fluence started above the Active (1e8 integrated pfu) threshold, but fallen sharply reaching 2.13e6 integrated pfu at 02/2400UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Low or Very Low, with a very slight chance of Moderate activity.

Solar Wind / Geomagnetic Activity: The effects of the current CME will continue to subside through day 1 (03 July). Further Earth-directed CMEs may arrive at the Earth early on 03 July and either late on 05 or into 06 July. A coronal hole high speed stream from coronal hole 96 may connect with the Earth on 04 July with speeds of 500km/s possible, although this connection is low confidence, due to the relative positions of Earth and the feature on the solar disc. The high speed stream from coronal hole 97 is then likely to connect with Earth on day 3 (05 July) with estimated speeds of 500km/s. There is a slight chance of G1/Minor Storms throughout much of the period, with a higher risk on day 3 due to the combination of the potential onset of the high speed stream from coronal hole 97 and the possible CME arrival.

Energetic Particles / Solar Radiation: In the absence of any significant sunspot development, the high energy proton flux (greater than 10 MeV) is expected to remain at background levels. High energy electron flux (greater than 2MeV) is expected to be mainly moderate to background through the next four days, with a slight chance of reaching the high (1e3pfu) threshold in any quieter geomagnetic periods on diurnal peaks. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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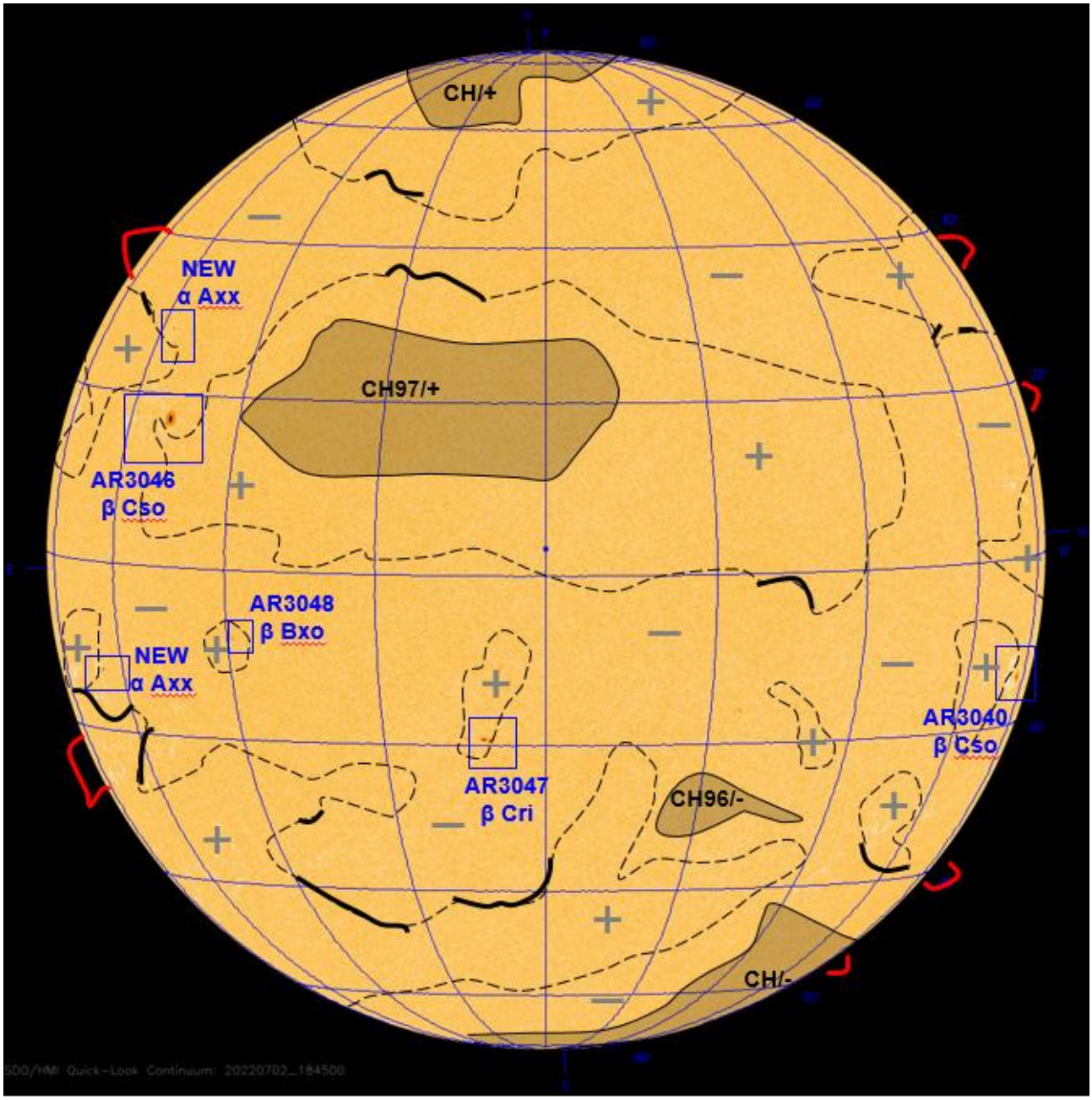
Figure 1. Solar Analysis Valid 02/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A CME arrived at Earth early on 02 July, with the waning effects of this still observed in L1 satellite data. Any prolonged rotation of the magnetic field to a negative polarity could result in further G1/Minor Storm intervals.

Early on day 1 (03 July) a further slow CME, which left the Sun on 28th June is forecast to arrive, with this perhaps generating further geomagnetic storms, as the previous CME may have primed the near earth environment. The high speed stream from coronal hole 96 may then connect with the Earth on day 2 (04 July). On passing STEREO A, this feature was observed with a high speed stream of around 700km/s and a significant CIR (co-rotating interaction region). Although the Earth is further north than STEREO A relative to the coronal hole, there is a chance that the Earth may observe speeds in the region of 500km/s.

On day 3 (05 July) coronal hole 97 is in a more favourable position on the solar disc to connect a high speed stream with Earth. Estimates of possible speeds are in the region of 400-500km/s, but as this feature is non-recurrent, confidence is low in these estimates. Either later on day 3 or during day 4 as further CME, which left the Sun on 29th June, may arrive at Earth, although there is lower than average confidence in this aspect of the forecast. As this may be combined with the high speed stream connection, there is a risk of G1/Minor Storms through days 3 and 4.

Overall, there is a slight chance of G1/Minor Storms on throughout much of the period, with a higher risk on day 3 due to the combination of the potential onset of the high speed stream from coronal hole 97 and the possible CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	20	30	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/1903	Partial	Filament	N18 W0	200	Late 04 or during 05 July	Very low confidence

See commentary for information on possible first CME arrival early on 03 July.

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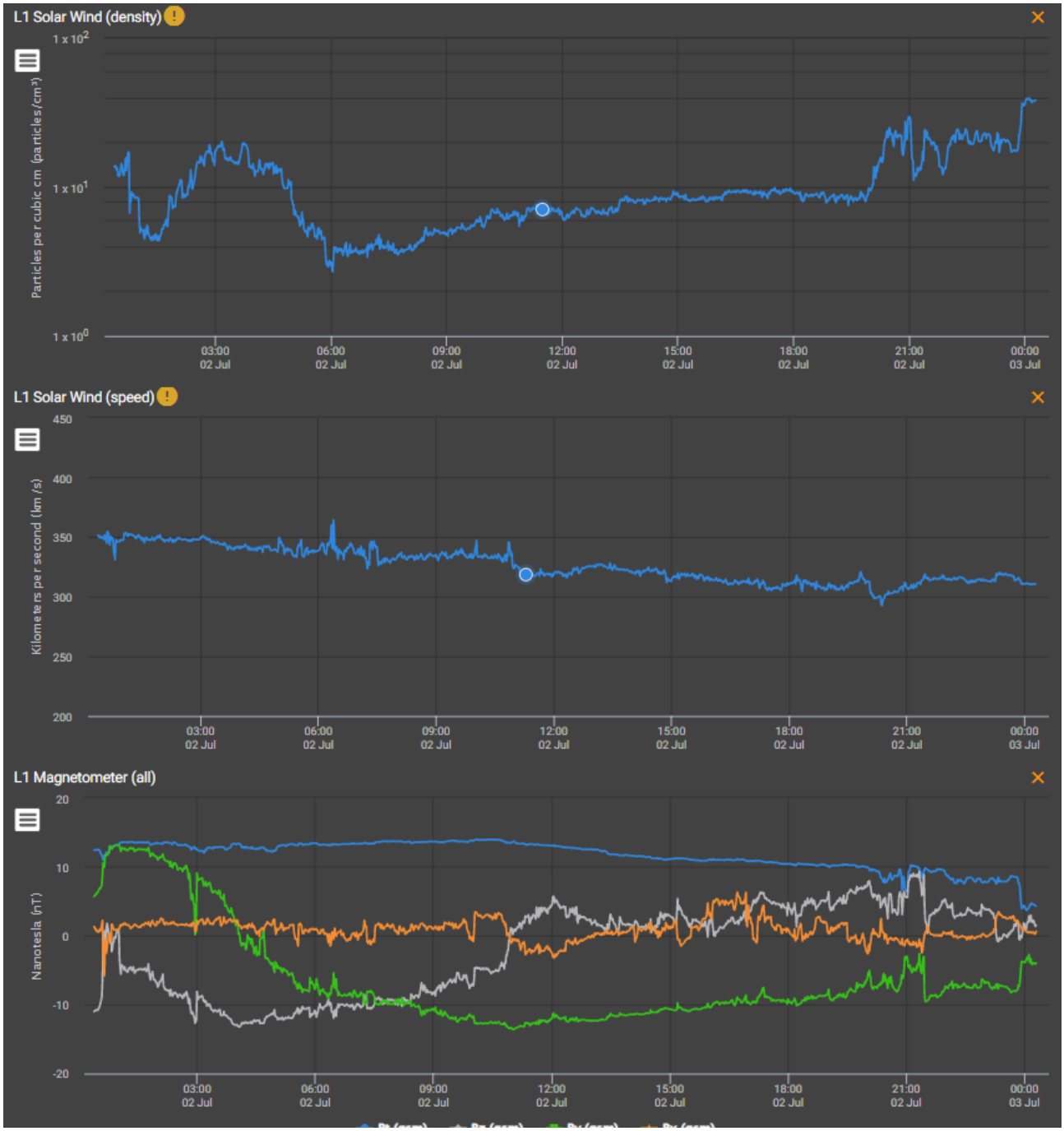
Figure 2: L1 observations of solar wind



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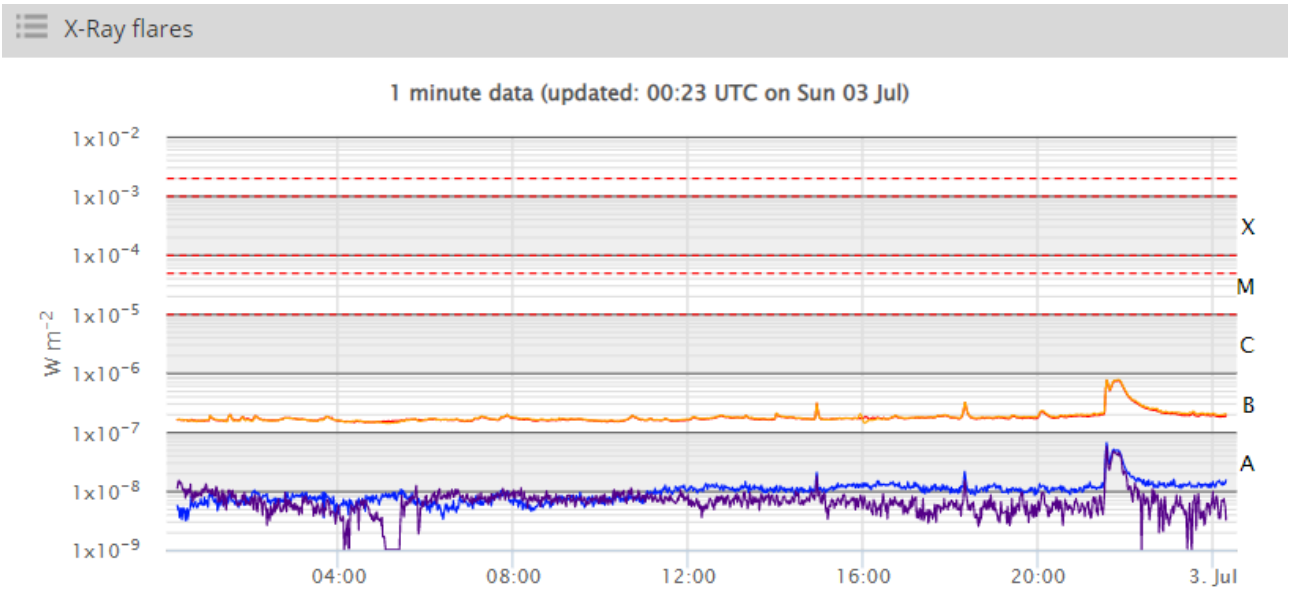
Radio Blackouts - X-Ray Flares:
There are six sunspot regions on the visible disc. AR3040 (Cso/Beta), the most mature of these is close to the southwest limb as a fading and inactive feature. AR3046 (Cso/Beta) has developed a trailer region through the last 24 hours with limited X-ray flux observed from the region. Given the recent developments, this will be closely monitored for further activity. The remaining regions are either weak, benign, or inactive and contribute little to the overall flare risk.

Solar activity is expected to be Low or Very Low through the next four days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16 X-ray flux. The B7.3 flare towards the end of the period is from AR3046.



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Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently at background levels, and will most likely remain at this level through the period, in the absence of any significant sunspot development.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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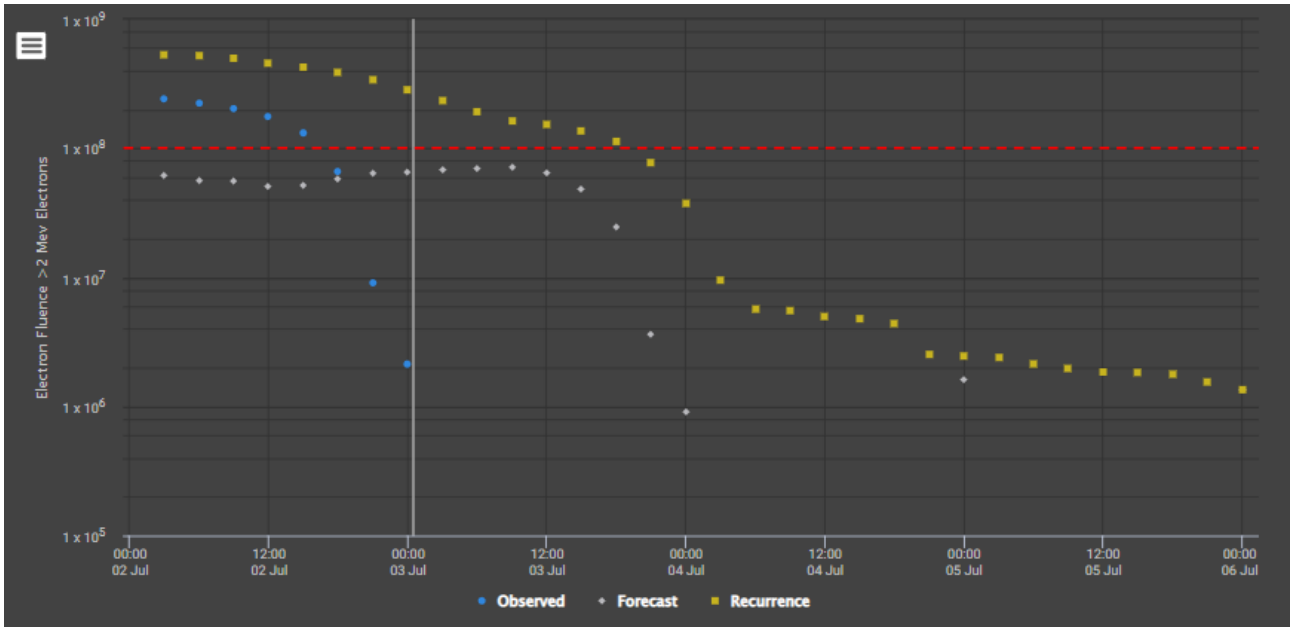
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has fallen to mainly background levels due to the redistribution in the belts following the geomagnetic storming on 01 July. Electron flux is likely to oscillate between mainly moderate and background levels due to the continued risk of storms. However, high (1e3 pfu) levels could be reached in any calmer intervals due to the large input of electrons into the belts from the forecast CMEs and high speed streams.
Electron fluence values have exhibited a sharp decline following the severe drop in electron flux values over the last 24 hours. Fluence is expected to remain below the Active threshold through the next four days, although slight upward trends are possible due to the possible periodic increases in electron flux.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	10	5	5	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM model



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